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Using Crop Residues for Soil Defense

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Using Crop Residues for Soil Defense

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By F. L. Duley, *senior soil conservationist, Division of Research, Soil Conservation Service,* and J. C. Russel, *cooperative agent, professor of agronomy, University of Nebraska*

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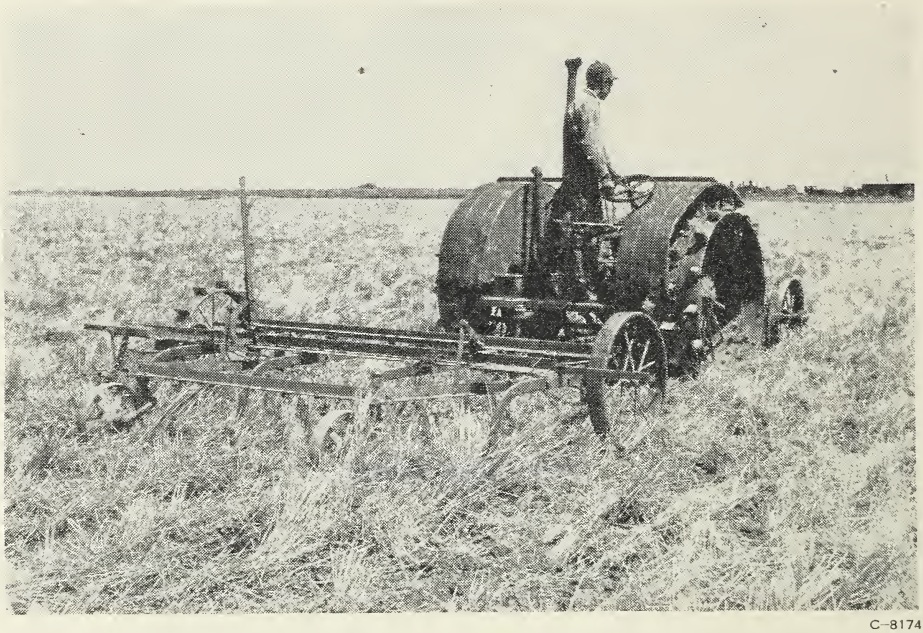
U. S. Soil Conservation Service, Office of Research, and Nebraska Agricultural Experiment Station, cooperating

Issued August 1942



C–8174

Summer fallow that leaves the stubble on top. Cultivating a few inches below the surface leaves crop residues on top. Wind cannot get at the soil under a cover like that on this wheatfield in the high Plains of western Nebraska. More rainfall penetrates the soil than when the field is bare.

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Cultivated Fields Need a Year-Round Cover

New methods of conserving moisture and soil that increase production are of vital importance to the war effort in which the farmers of the United States are engaged as this publication goes to press. It is fortunate that the facts presented in this bulletin on the use of crop residues have been established at such an opportune time.

Some of the methods described in the following pages will seem as startling and revolutionary to many farmers as the new methods of waging war have seemed to all peaceful peoples throughout the world. Nevertheless, because of their effectiveness in increasing production, these new ways of saving moisture and soil fertility are being used by more and more farmers in some of the most important agricultural areas of the United States.

Some of the farm machinery that is described in the text and shown in the pictures may become unavailable as the need of war material for our armed forces cuts down the supplies of metals for home consumption; but the principles and practices that are here explained may play an increasingly important part in obtaining the greatly enlarged volume of food and fiber that our farmers must produce to insure victory.

In the spring of 1938 the Office of Research of the Soil Conservation Service and the University of Nebraska began experiments designed to study the value of leaving crop residues on the surface of cultivated fields as a means of conserving soil and water. Since that time similar experiments have been begun by the Soil Conservation Service at agricultural experiment stations in other parts of the country.

The term "crop residues" is used in this publication to include materials such as stubble, straw or stalks from various crops, or even old weed growth.

If crop residues are left on the surface of cultivated plots and fields to supplement the part-time protection afforded by the growing crops it is possible to keep the soil continuously protected against excessive losses. The need for year-round cover is well known. The experiments at the University of Nebraska have shown that crop residues protect the soil against high runoff and excessive erosion by wind or water and slow down evaporation.

It remains to develop and perfect practical methods of preparing seedbeds, planting crops, and cultivating row crops on land protected by a cover of residues. It is necessary to work the soil beneath the surface so as to disturb the residues as little as possible. Considerable progress toward this goal has already been made.

In this publication is a pictorial record of the experiments conducted at the University of Nebraska, showing the effectiveness of crop residues as a means of conserving soil and water, the progress made in the design and use of machinery for subsurface tillage, and crop yields.

As the studies at the Nebraska station and those at other experiment stations progress and as farmers have more experience with methods of utilizing crop residues, the degree of practicability of these methods and their adaptation to different sections of the country will be gradually established.

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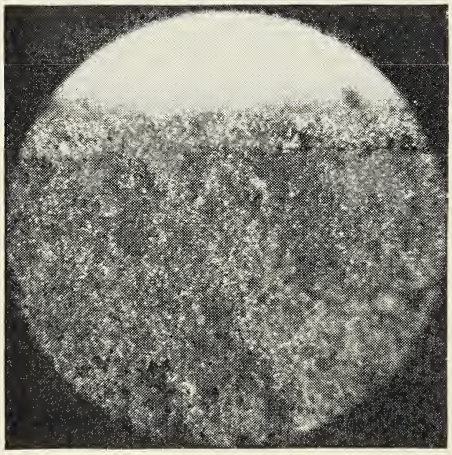
C–8216

A soil surface compacted by heavy sprinkling.

Heavy Rainfall Compacts Bare Soil

Drops of water falling on a bare soil change the structure of the soil. The surface becomes compacted. A compacted surface layer prevents the rapid penetration of rainfall or of water applied by sprinklers. The photograph above shows the surface of a mellow soil after the plot had been heavily sprinkled. Likewise, a heavy rain falling on a clean, finely prepared seedbed soon compacts the surface. Then the water can enter the soil at only a slow rate and much of it may be lost as runoff.



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A half-inch vertical section of a soil having a compact layer at the surface about one-sixteenth inch thick.

In this vertical section of soil from a sprinkled plot the compact layer on the surface is clearly distinguishable from the underlying soil. The structure of the soil at the surface has been changed greatly by the impact of the water falling on it. In this thin, compacted surface layer there are no large openings (indicated by the dark areas). Water penetrates the soil slowly after such a compact layer has been formed at the surface. If a soil is to retain its maximum capacity for absorbing rainfall the surface must be kept open.

Before this plot was sprinkled it had been cultivated and left bare.

C-8155

C-8193

Before this plot was sprinkled it had been cultivated and covered with straw.

Crop Residues Increase Infiltration

It is possible to prevent the formation of a compact layer on cultivated soil by protecting the surface with crop residues such as combine wheat stubble and straw.

Here are two plots, one covered with straw and one bare. Both were sprinkled. On the surface of the bare plot a compact layer soon formed, which greatly increased the runoff. Under the straw the surface remained more open and the intake rate was high. During heavy rains two to four times as much water may be lost from a soil having a bare surface as from one covered with crop residues.

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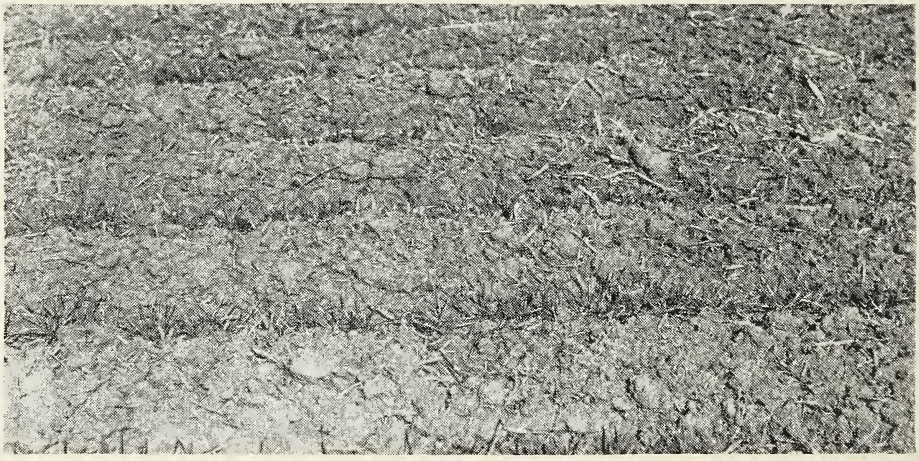
Plot 1: Plowed land not mulched.



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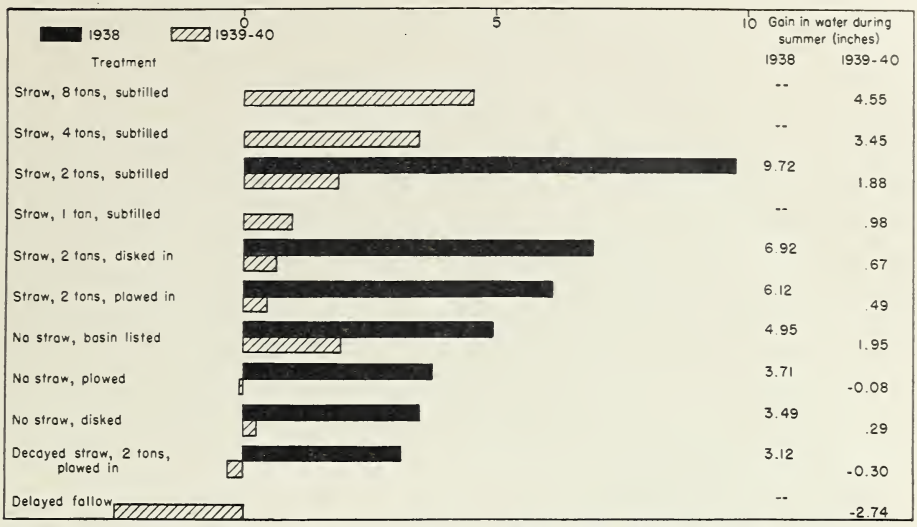
Plot 2: Some straw remains on the surface a year after the mulch was applied.

Crop Residues Improve the Structure of the Soil

Both these plots were fallowed during the summer of 1939 and seeded in the fall to winter wheat. Plot 1 was plowed land. Plot 2 was covered with 4 tons of straw per acre in April 1939 and subsurface-tilled during the summer. The photographs were made in April 1940.

The plot on which 4 tons per acre had been applied shows a much more granular structure than the plot plowed without any straw. This plot is smooth and broken into large blocks.



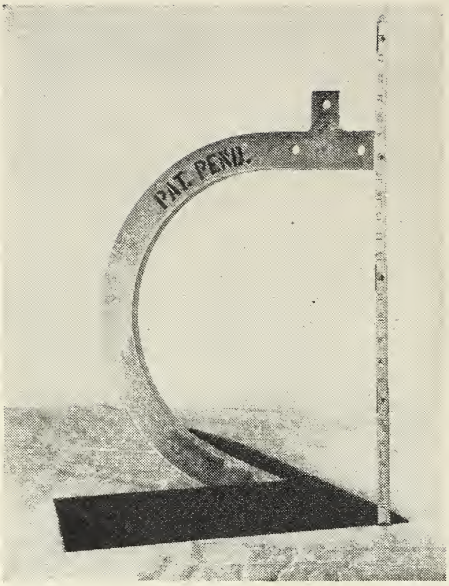
Amount of water accumulated in the soil during the summer-fallow period on fields cultivated with the ordinary types of tillage equipment and on fields protected by a crop residue and subsurface-tilled.

Moisture in summer-fallowed fields

During 1938, 1939, and 1940 a study was made to determine the amount of water accumulated in the soil during the summer-fallow period under ordinary types of tillage, such as plowing and disking, and that accumulated under crop residues on fields tilled by means of subsurface-tillage equipment. In 1938 the rainfall was about normal; in 1939 and 1940 it was much below normal. The soil-moisture measurements were made on plots uncropped and, with one exception, free of weeds. The results of the tests are recorded in the chart above. The figures for 1939–40 are averages.

The length of the bars indicates the increase in soil moisture in the upper 6 feet of soil from April to September. For example, the plot receiving 4 tons of straw and subtilled shows a gain of 3.45 inches. This means that the amount of water accumulated in this plot during the summer is the equivalent of that in 3.45 inches of rainfall.

On the delayed-fallow plot the weeds were allowed to grow until about the first of July. The plot was then subtilled and the weeds were used as cover during the remainder of the fallow period. The loss in moisture during the summer, indicated by a negative value on the chart, shows that weeds remove large amounts of water from the soil.



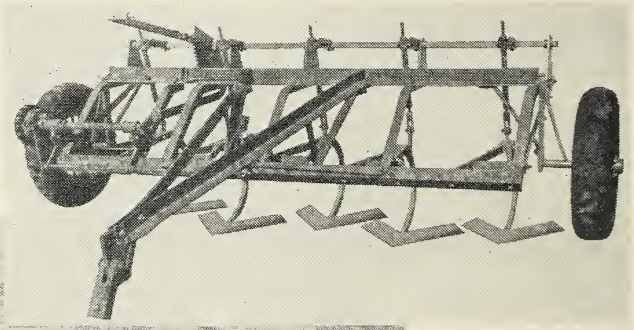
C–8181

The first type of sweep designed for subsurface tillage.

Subsurface-Tillage Equipment

To till the soil thoroughly without destroying the residues it is necessary to have equipment designed for this special purpose. Several implement companies manufacture machines well adapted for this work. All these tillage implements provide for some type of sweep or blade running beneath the surface. The blade loosens the soil but does not turn it over or bury the residue.

If equipped with rolling coulters, this 8-foot five-sweep subsurface-tillage machine will work through heavy residues and leave practically all the cover on the surface.



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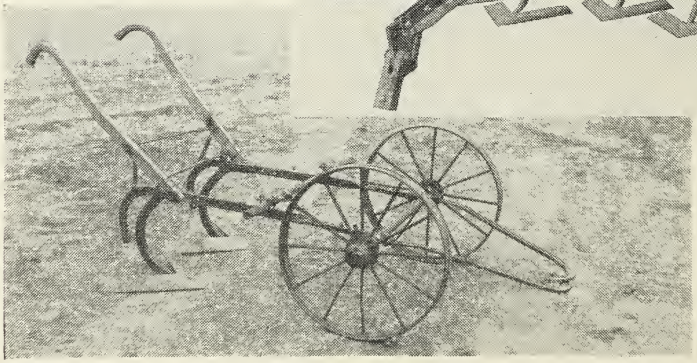

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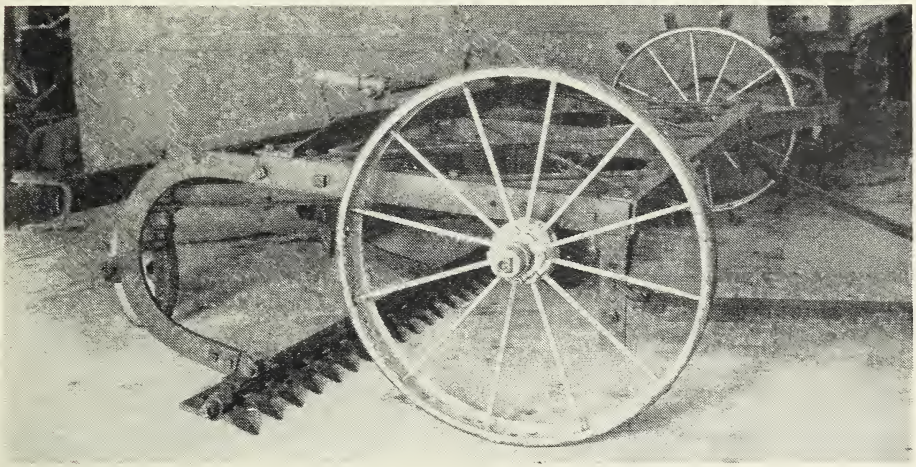
The first experiments at the Nebraska station were conducted with sweeps mounted on this improvised carrier.

C–8196

Subsurface tillage through combine wheat stubble.



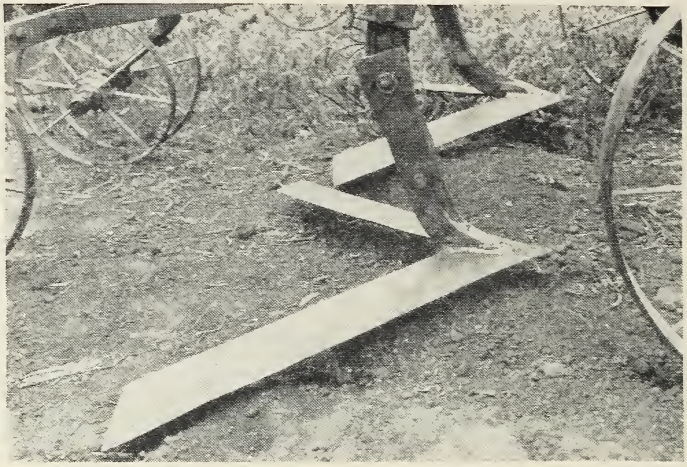
C–8180

Subsurface-tillage attachment on a rod weeder.

Preparing the Seedbed Through Residues

In summer fallowing or in preparing the land for the next crop, the first subsurface tillage should be about as deep as ordinary plowing. At later operations, when the main objective is to kill weeds, the depth of tillage should be about 3 inches. Usually two to four tillage operations will be required for summer fallow or for seedbed preparation for winter wheat.

The bar with the teeth, shown above, is an attachment for a rod weeder. This equipment will pass through trash that is not excessively heavy, and it does a good job of working the soil.



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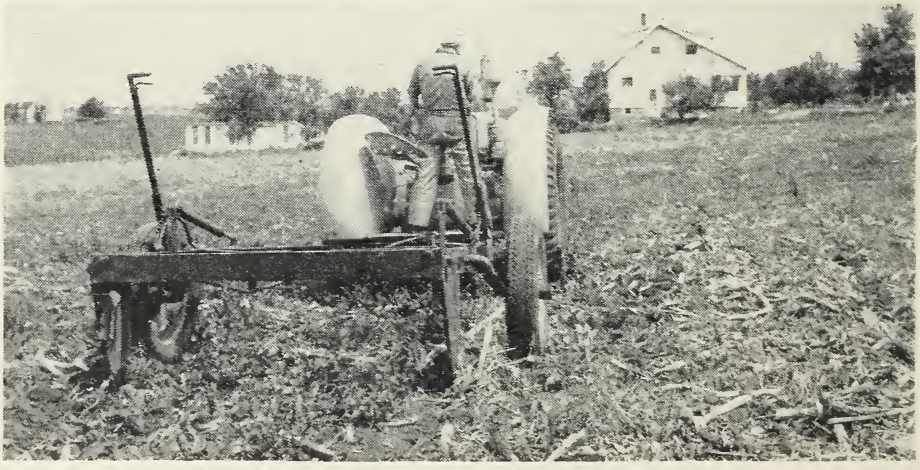
Large subsurface-tillage sweeps on a two-row lister.

Another attachment is illustrated above. These large 45-inch sweeps are bolted to the beams of a two-row lister after the listers have been removed. Regardless of the type of equipment used for subsurface tillage, it is important that the soil be thoroughly worked, all the residue evenly distributed on the surface, and the surface left without ridges.

The subsurface tiller shown below has a long, straight blade that is pulled at right angles to the direction of travel. This implement was originally designed and manufactured in Canada for use in wind-erosion control.



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A straight-blade subsurface-tillage cultivator.

C–8195

This implement smooths and packs the soil without burying the residue.

On many fields subsurface tillage leaves the ground too loose for a good seedbed. It is therefore necessary to compact the soil without covering the residue.

If crop residues are left on the surface of a field the ordinary disk and harrow cannot be used for packing the seedbeds. A packer that will not bury the straw or drag it into bunches is needed. A rotary hoe with the wheels reversed, such as that shown above, does the work satisfactorily. It does not clog in trashy ground.

A semideep furrow, 10-inch drill operating in residue-covered ground. Too much straw is being covered, but enough remains on top to give much protection against runoff and wind erosion.

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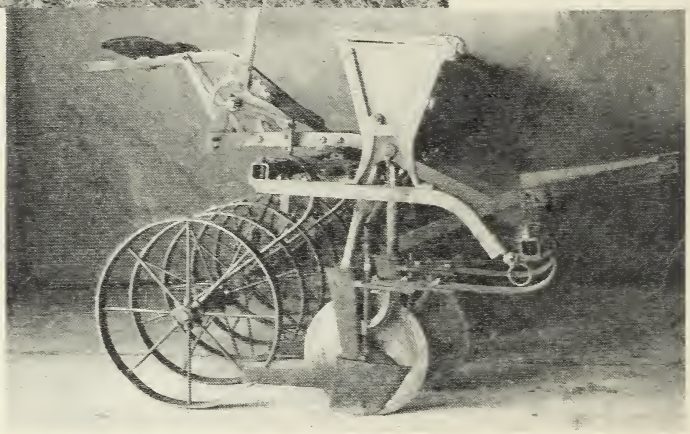


C-8187

A press drill equipped with flat disks for working through residue. Wings have been attached to the shoes to push the residue to the side of the wheel.

Seeding Small Grain

In drilling small grain, sufficient residues should be left on the surface between the rows to give protection against water and wind erosion until the young plants develop sufficiently to protect the soil. The common wide-space drills may be used with fairly good results. Where the residue is heavy, drilling small grain is rather difficult. Several new types of drills have been tested.

One of the most successful of these drills is a press-wheel drill with flat disks set at a slight angle and a wing attached to each shoe to brush the residue aside until the wheel passes. This leaves a clean furrow in which to plant the wheat and leaves the residues on the surface between the rows.

C–8183

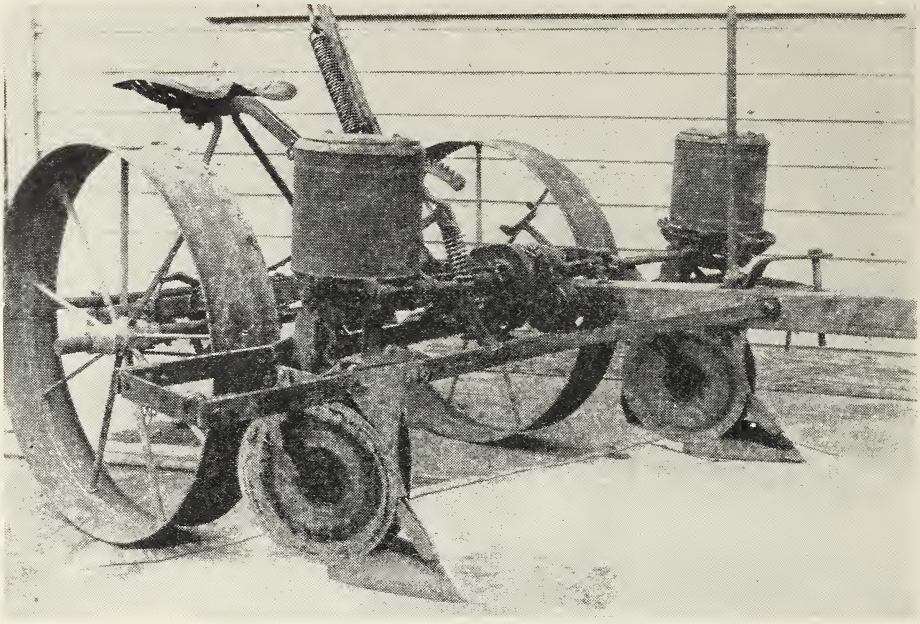
Land prepared for corn by subtillage beneath wheat residues. The corn was planted with disk furrow-openers on the planter.

Planting and Cultivating Row Crops

In preparing land for row crops, it is subsurface tilled and thoroughly packed. Seed is then planted through residues with a cornplanter to which disk furrow-openers are attached. Cultivation is done with large sweeps attached to a corn cultivator. Thus the residues are left on the surface throughout the season to increase the intake of water and reduce erosion.

C–8194

Cornstalks broken with a stalk-cutter were left on the surface to protect the soil. The field was then subsurface-tilled and planted to corn in small furrows.



C-8191

A corn planter equipped with disk furrow-openers attached to stub runners. With this equipment corn or other row crops can be planted satisfactorily through residues.

C-8175

A corn cultivator to which has been attached sweeps and rolling coulter shields. The side thrusts of the sweeps push sufficient soil into the furrow to cover the weeds, and the rolling shields prevent covering the young plants.

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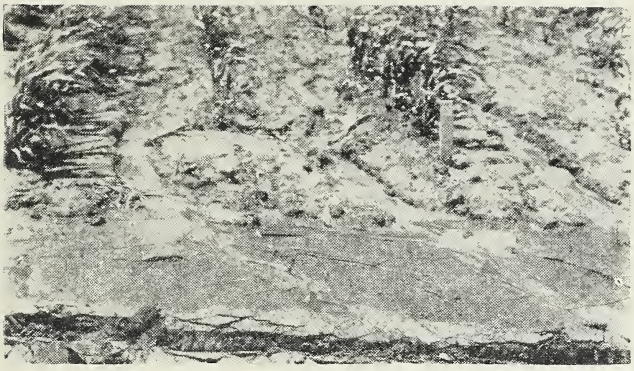

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C-8192

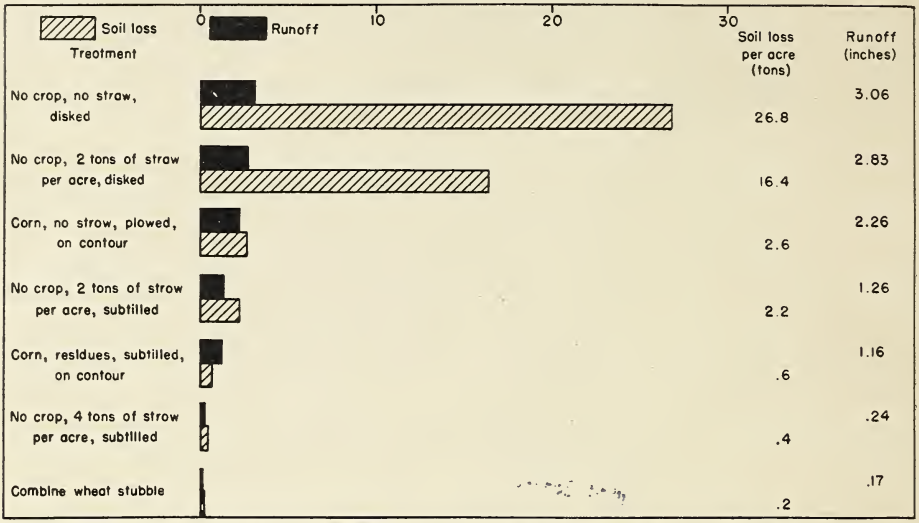
Serious erosion occurred on the unprotected cornfield above during a 2-inch rain. During the same rain the field below, protected by crop residues, lost little of either water or soil. These two pictures were taken the day after the rain on the same 7-percent slope at locations about 100 feet apart.

C-8182

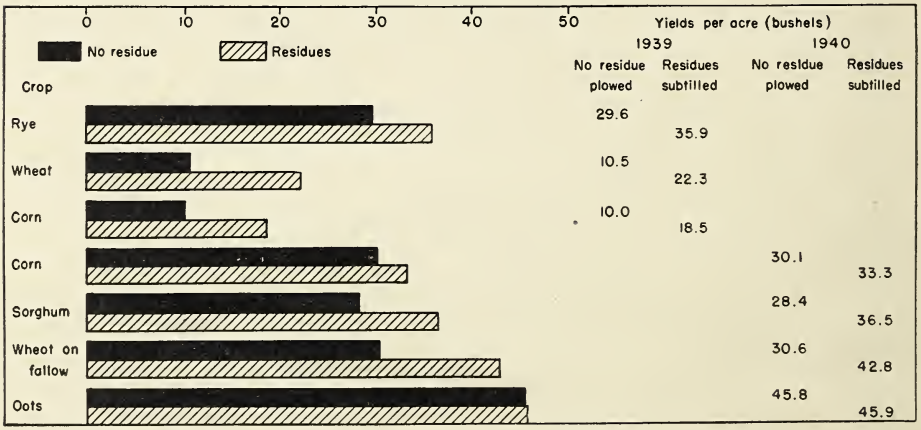
Straw residues on this 15-percent slope practically stopped runoff and erosion. The field is in sorghum.

Effect of surface residues on soils and water losses and on yields

Crop residues on the surface of cultivated fields reduce loss of water by runoff and loss of soil by erosion. Also on fields protected by crop residues yields have been maintained or increased. The two charts on this page show this.



Soil loss and runoff that occurred on fields receiving different crop, cover, and tillage treatments July 27 to September 23, 1940. The rainfall for this period was 7.12 inches.



This chart is a record of the tests for yield. It permits a comparison of crop yields from plowed land and from land on which crop residues had been left on the surface of the soil. The yields are for 1939 and 1940. Several years' tests will be required to show what average yield can be expected.